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(54) **Infra-red radiation detector assembly**

(57) An infra-red radiation detector assembly comprising a radiation detector element or array thereof 3, a focussing lens 14 and/or mirror arrangement, perhaps forming part of an optical scanning system, for focussing received radiation onto the detector element, and a screen or mask 10 surrounding the path of the radiation passing to the element 3 and operable for shielding the element 3 from stray radiation. To avoid a problem with previously known assemblies whereby radiation reflected or emitted from the element 3 itself is reflected from the internal surface of the screen 10 back onto the element 3, perhaps onto precisely the same spot from which it came, that internal surface is herein so shaped 11, *e.g.* by being spheroidal or off-axis part spherical, that radiation coming from the region of the detector element is diverted onto a non-reflective surface 8 surrounding the element 3.

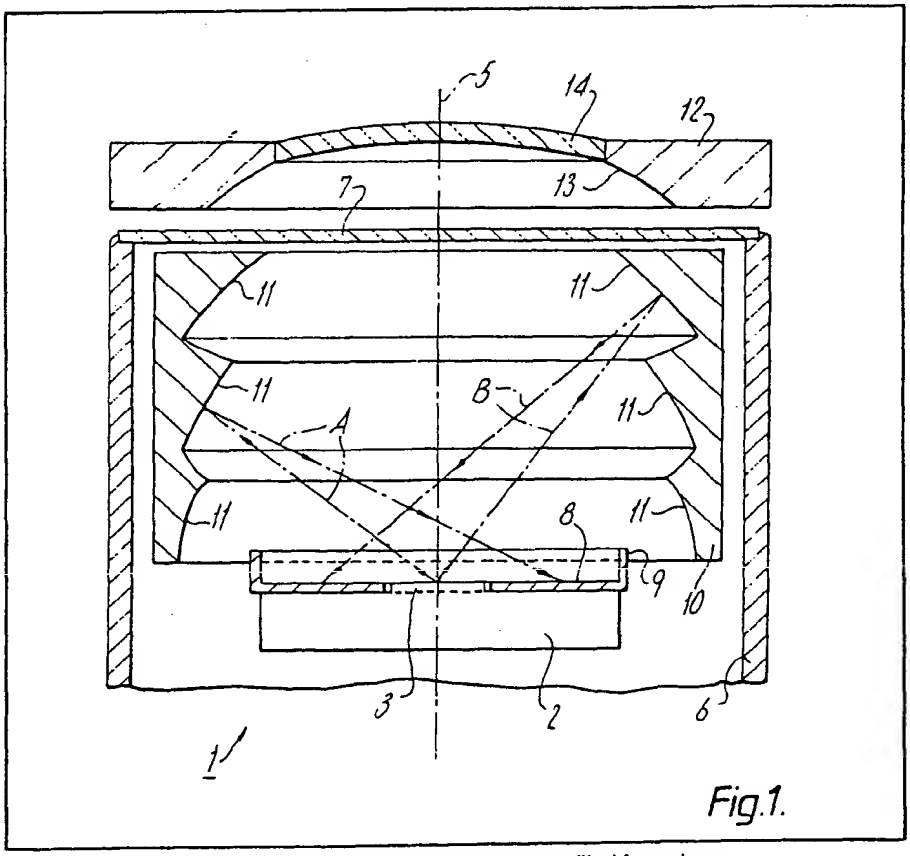

Fig.1.

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The drawings originally filed were informal and the print here reproduced is taken from a later filed formal copy.

Fig.1.

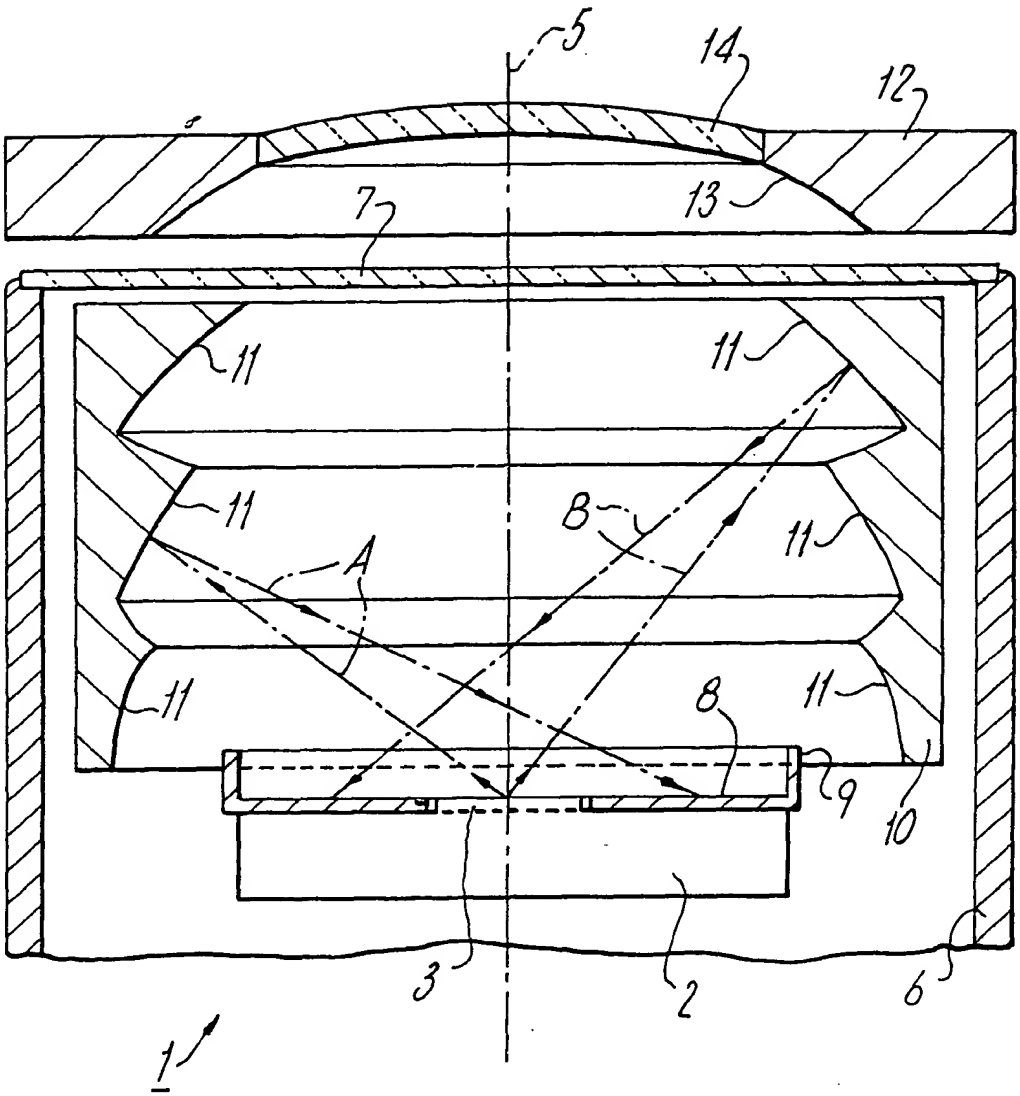

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Fig.2.

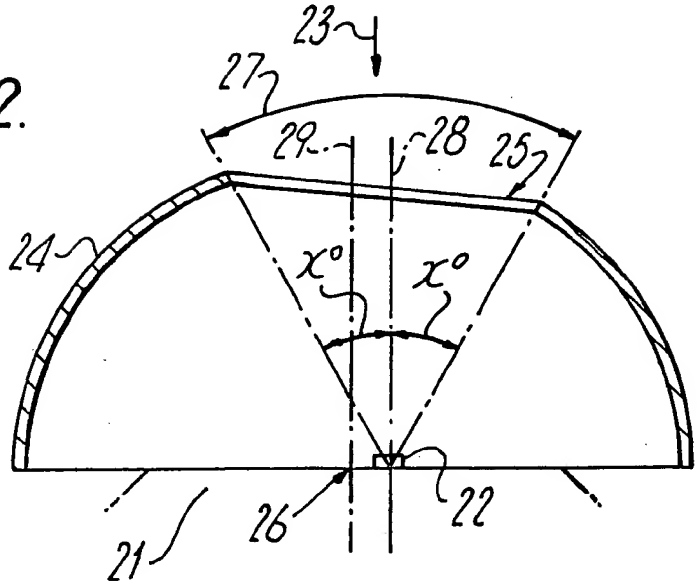
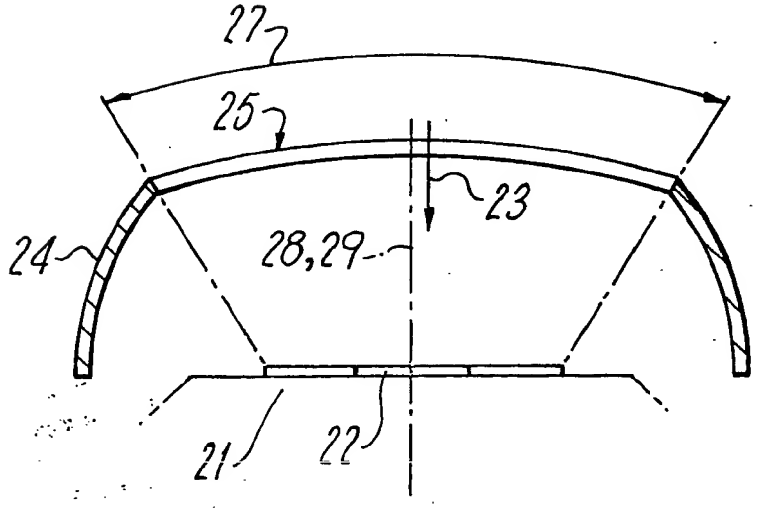


Fig.3.



SPECIFICATION

IR radiation detector assembly

This invention relates to infra-red radiation detectors and to a screen or shield for reducing certain undesired phenomena which may occur in connection with such a detector.

In a thermal-imager, infra-red radiation from a field-of-view is passed to a radiation detector *via* an optical system including in series an objective lens, an optical scanning assembly comprising say an oscillating plane mirror and a rotating polygonal mirror, and a focussing lens. The operation of the scanning system is such that the portion of the field-of-view from which radiation is actually received by the detector moves over the field-of-view in say a linewise scan pattern. The detector may comprise a single detector element or "photosite' or it may comprise a matrix or array of such elements.

The value of shielding such a detector used in a thermal imager from radiation "noise" such as stray radiation from emissive parts of the imager itself is known. In particular, it has been proposed to place between the focussing lens and detector element of a thermal imager, a cylindrical screen or shield of which the inner surface is highly reflective and of low emissivity and is indented to define a large number of "corner cube reflectors" which have the property of reflecting any received radiation along a return path parallel to that by which it arrived. With such a shield, the only radiation which can be reflected by the shield onto the detector is radiation which has come from the detector itself and this detector is assumed to be a "cold body". However, in fact, the detector can reflect or scatter some of the image radiation which it receives and, if so, this radiation would be returned by a corner cube reflector shield to the detector to give an effect whereby any image "hot-spots" are spread-out, possibly even to the point where nearby low-contrast image items become obscured.

According to the invention there is provided an infra-red radiation detector assembly including an infra-red sensitive element, focussing means positioned for passing received infra-red radiation to said element, non-reflective surface defining means positioned around the element and, between said focussing means and said element, a screen having at least one reflective, low-emissivity internal surface portion disposed around the path of radiation passing from the focussing means to the element and facing in the general direction of the element, the surface portion being operable for reflecting any radiation received thereby from the direction of said element towards said non-reflective surface defining means.

It will be appreciated that a detector assembly according to the invention could be used, not only in a thermal imager, which term may have come to mean only the aforedescribed t.v. camera-like apparatus where a two dimensional scan of the field-of-view is performed by scanning means within the imager, but is more generally applicable, for example to other kinds of infra-red surveillance apparatus, such as aircraft line-scan equipment and equipm nt where scanning as such is not done at all, and also to communications equipment and the like.

For a better understanding of the invention reference will now be made, by way of example, to the accompanying drawings, in which:-

Figure 1 is a diagrammatic sectional view of an infra-red detector assembly, and

Figures 2 and *3* are a diagrammatic sectional elevation and a diagrammatic sectional side view respectively of a second infra-red detector assembly.

The detector 1 of the illustrated assembly comprises a substrate 2 upon which there is formed a matrix 3 of infra-red sensitive sites and which may be cooled, by cooling means which is not shown, to the required low operating temperature of the matrix 3. A focussing lens 4 is mounted with its optical axis 5 incident on the matrix 3 so as to focus onto the array infra-red radiation received by the lens from say the optical scanning system (not shown) of a thermal imager in which the detector assembly is used. The detector is enclosed in a Dewar flask 6 (only partly shown) having a flat infra-red transparent window 7 which extends between the detector 1 and lens 4.

The surface of substrate 2 around matrix 3 is covered by an apertured cover plate 8 having a non-reflective surface facing away from substrate 2 and a flanged outer edge 9, the flange extending towards window 7. The plate is cooled along with the substrate 2. The central aperture in the plate surrounds the matrix 3 quite closely while nevertheless being such that a small gap is present between the plate and matrix. A shielding cylinder 10 is positioned between the window 7 and detector so as to surround the axis 5. The internal surface of this shield is annularly recessed so as to define a series of three reflecting surface portions 11 which are coaxial to axis 6 and which are inclined to face in the general direction of the matrix 3. Each surface portion 11 corresponds to the surface of a segment of a spheroid formed by the rotation about axis 6 of an ellipse having one focus at the point where axis 6 meets matrix 3 and its other focus at a point upon the exposed surface of plate 8. The shield 10 is not cooled but it is made of such material or is so treated that at least the portions 11 of its internal surface ar of high reflectivity and low emissivity. By way of example, the shield may be made of aluminium or plastics material with a suitable reflective coating. It is preferred but not essential that the internal surface portions 12 of the shield between the portions 11, i.e. the portions facing away from matrix 3, should also be reflective.

The mounting 12 for lens 4 is profiled so as to present, in the direction towards the matrix 3, a reflective surface portion 13 like the portions 11, *i.e.* corresponding to a segment of a further spheroid formed by rotating about axis 6 an ellipse with its foci common to those of the surface portion 11 ellipses.

Radiation emitted or reflected from the surface of the matrix 3, say the radiation represented by beams A or B, is reflected by surface portions 11 and/or 13 onto the plate 8 rather than back onto the matrix 3.

Instead of using the plate 8, the surface of

substrate 2 around matrix 3 could be rendered non-reflective by treatment of the substrate surface and/or the application thereto of a suitable paint-like coating.

The elliptical sectional shape of the surfaces 11 and 13 could be modified to some other suitable shape which, like that illustrated, diverts at least most of any radiation received from the matrix 3 to a position away from the matrix. By way of particular example, although the described shape of the reflecting surfaces 11 and 13 is more generally advantageous, many detecting assemblies to which the invention can be applied are of dimensions such that there is only a slight observable difference between a reflecting surface portion having the described shape and one which corresponds to a segment of a spheroid formed by rotating a circle instead of an ellipse around axis 6. Thus, in some cases, the surface portions 11 and 13 could have this latter shape.

Instead of having a plane cylindrical outer surface as shown and a thick wall deep enough to accommodate the recesses defining the surfaces 11, the shield 10 could be made of relatively thin sheet material so that the outer surface varies in diameter to follow the inner surface.

It will be realised theat the focussing lens means of the above described infra-red radiation detector assembly can be replaced by the obvious mechanical equivalent of a focussing mirror or arrangement of mirrors giving an overall focussing effect, or a combination of one or more mirrors and one or more lenses.

Particularly but not exclusively in a case where the detector element comprises a linear array of photosites instead of the/or each reflective low-emissivity internal surface portion such as the portions 11 in Figure 1, being spheroidal it may be part spherical, preferably hemispherical, the portion being radiussed about a point in a plane displaced to one side of the detector element as shown in Figures 2 and 3 for example.

The detector assembly illustrated in these figures comprises a cooled substrate 21 upon which there is formed a linear array 22 of infra-red sensitive sites. Radiation 23 from a viewed scene is focussed onto the array 22 by say an optical scanning system (not shown) which comprises a focussing mirror or mirror/lens combination (also not shown). Alternatively, the focussing could be done by a lens forming part of the detector assembly. Around the path of the radiation 23, there is disposed a screen 24 which is like a hollow hemisphere with an elongate aperture 25 in it, the long sides of the aperture being aligned with the long sides of the array 22. The reflective inner surface of the screen faces generally towards the array 22 and the screen is so positioned relative to the array that, in Figure 2 where the view is in a direction parallel to the long sides of the array 22, the internal surface of the shield is radiussed about a point 26 on the substrate 21 displaced to one side of the array. Thus, radiation received by the shield from the array is reflected, not back to the array, but instead onto the substrate 21.

Instead of a simple hemispherical screen, there could be two or mor positioned one above another. Also the or each shield could be replaced by a thick-walled generally cylindrical or oblong member with one or more internal annular recesses defining respective hemispherical surfaces.

In the particular example of Figures 2 and 3 the aperture 25 is so positioned that the field-of-view 27 of the detector array 22 is symmetrical with respect to the optical axis 28 of the focussing system which directs the radiation onto the array. Thus, the aperture is not symmetrical with respect to the 'centre line' of the shield, *i.e.* the line 29 which is parallel to axis 28 and which passes through the centre of radius 26. In other words, in Figure 2, the aperture 25 is not centered at the 'top' of the shield but is instead displaced over towards the detector array.

CLAIMS

1. An infra-red radiation detector assembly including an infra-red sensitive element, forcussing means positioned for passing received infra-red radiation to said element, non-reflective surface defining means positioned around the element and, between said focussing means and said element, a screen having at least one reflective, low-emissivity internal surface portion disposed around the path of radiation passing from the focussing means to the element and facing in the general direction of the element, the surface portion being operable for reflecting any radiation received thereby from the direction of said element towards said non-reflective surface defining means.

2. An assembly according to claim 1, wherein the or each internal surface portion is an annular surface corresponding to the surface of a segment of a spheroid formed by rotating about an axis intersecting said element a two-dimensional curved geometrical shape.

3. An assembly according to claim 2, wherein said shape is an ellipse having one focus coincident with the point at which said axis intersects said element and its other focus on or adjacent to said non-reflective surface.

4. An assembly according to claim 2, wherein said shape is circular.

5. An assembly according to claim 1, wherein the or each internal surface portion corresponds to part of a sphere.

6. An infra-red radiation detector assembly substantially as hereinbefore described with reference to Figure 1 or Figures 2 and 3 of the accompanying drawings.

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